Improving Online STEM Education through Direct Industry Classroom Engagement

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She has worked with a team of colleagues throughout other colleges at East Carolina University to plan a STEM initiative for 8th grade girls. This initiative helps bring more than 100 Pitt County girls to campus to engage them in Science, Technology, Engineering, and Math. She has also worked with ECU's Global Academic Initiatives to collaborate with other institutions throughout the world.

In addition, Dr. Pagliari collaborates with many external organizations. She is past president of APICS (Association of Operations Management) and past Education Chair for the CSCMP (Council of Supply Chain Management Professionals). She also served as a board member for the Museum of the Marine in Jacksonville, NC and the Eastern Carolina Safety and Health School. She continues to serves on multiple organizations with the University, College, and Department. Dr. Pagliari was selected and completed the BRIDGES Academic Leadership for Women hosted by UNC-Chapel Hill and was recently nominated for the Women of Distinction award at East Carolina University..

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1. Introduction

State governments continue to push public Universities to be more focused on providing students with the skills and knowledge sought after by prospective employers. STEM related recruiters increasingly seek graduates from higher education programs who have applied their academic knowledge to real-world scenarios. To meet these demands, academia must get closer to industry and work directly with professional practitioners to fully understand their specific needs and to adjust curriculum and coursework accordingly.

A novel approach to bridging the gap between academia and current practice the "Industry Fellows" model, developed and tested by faculty at the University of Washington, Tacoma [1]. This model goes beyond the typical industry engagement pathways of industry advisory boards, guest speaker events, student internships, and capstone projects. Industry Fellows is a form of industry/academia collaboration providing direct engagement of an industry professional within the classroom throughout a semester. This direct engagement has the benefit of bringing academic instruction and state-of-the-art industry practices into closer alignment [1].

The goal of this paper is to extend the Industry Fellows model from application in face-to-face delivery into online delivery for distance education. Both the original research and this study utilize information technology courses at undergraduate and graduate levels. Case studies compare face-to-face versus online applications of the model through analysis of student survey data from both the original study and this new extension of the model. The paper concludes with lessons learned and a methodology for online delivery of the Industry Fellows model.

2. Industry Fellows Overview

In *Rethinking Expertise*, Collins states "mastery … cannot be gained from books … but can sometimes … be gained by prolonged social interaction with members of the culture that embeds the practice" [4]. The Industry Fellows model was developed on the premise that academics in technology disciplines require continual "refreshing" of their skills due to the rapid rate of technological change and tools. The challenge to faculty at state universities includes shrinking state appropriations and more competitive grant funding inhibiting technology hardware and/or software upgrades to maintain pace with industry and technology advancement.

Industry Fellows was conceived to gain access to state of the art technology and business practices, industrial artifacts, such as reporting and project management techniques, and industrial expertise through a mutually beneficial collaborative model. The model is "based on research into sociocultural theory, expertise, the use of mediating representations, and the importance of intrinsic motivation" [1], and has four foundational characteristics for successful faculty/professional collaboration:

- viewing learning as participation
- dividing labor along lines of expertise
- using artifacts to mediate interaction
- choosing industry professionals and academics with intrinsic motivation to participate

Specifically, the Industry Fellow model requires close collaboration and partnership between a faculty member and an industrial practitioner, i.e. the "industry fellow." The goal of the model is "joint curriculum review, planning, and teaching" of a course closely aligned with the professional's current work/projects [1]. The partnerships requires faculty to bring pedagogical, teaching, and course management expertise to compliment the industrial expertise being offered. Faculty maintain responsibility to create and manage all course content as the industry professional's main interactions are course consultant, content provider, ad hoc lecturer, and most importantly for the model's success, student interaction and feedback.

The original research by Tenenberg into Industry Fellows presented two methodologies, which were termed "light" and "heavy" [1]. In the "light" version, the industry professional only attended the first and last class meeting in person, and had a fifteen-minute virtual interaction via Skype. Additionally, the industry professional provided three short video tutorials of approximately two minutes. Feedback was provided through the instructor after weekly one-on-one-phone calls with the industry professional, i.e. a "consultant" version.

In the "heavy" version, the industry professional would attend one of two weekly face-to-face lectures with the instructor. The main professional responsibility was to transmit expertise and learning through critique and feedback of student work in progress and project presentations, i.e. a "participant" version.

In either case, the model's design exploits each participant's expertise. It is the joint planning between faculty and professional, plus the professional's interaction and feedback role that distinguish Industry Fellows from a "guest speaker" series. When the model is enacted, there is continual industry professional engagement throughout the semester. To provide a degree of socialization/interaction not typically present during a guest lectures, students presentation to the professional for feedback. It is incumbent on the faculty member to maintain all administrative, organizational, and grading efforts since the professionals acting as Industry Fellows do so on a strictly voluntary, uncompensated basis.

3. Industry Fellows Benefits

Enacting the model of direct industry engagement creates a mutually beneficial relationship between students, industry, and academia. However, this model is not a methodology for an adjunct or contingent faculty. This is for uncompensated, voluntary participation by an industry professional willing to work with a university instructor.

The benefit to students is that professionals in an adjunct role generally have the best intents, but lack pedagogical expertise. Much expertise is considered tacit knowledge in that most of it was learned by "doing" rather than the study of theory [2]. Torff's "transmission model" [3] essentially defines teaching as presenting information and having it (organically) enter a student's mind. Adjuncts will generally rely on intuition and experiential acquisition rather than scientific research or a tested pedagogy [1]. It follows that industry professionals in an adjunct or contingent faculty role will generally attempt to transmit expertise tacitly, i.e. knowing how to do things, but have difficulty trying to explain to others [4].

Tenenberg extends learning theory by stating that expert tacit knowledge may be better transmitted through social channels [5]. He combined faculty and industrial professional expertise within a quasi-social environment suitable to higher education, which lead to the

development of the Industry Fellows Model [5]. The goal of Industry Fellows is to replace a transmission model with a sociocultural learning model. Thus, the joint collaboration and expertise between faculty and professional provide an improved student-learning outcome.

Industry Fellows also provides professional and personal benefits. Professionally, direct engagement may be a source of new and/or non-conventional ideas from the next generation of STEM graduates. Personally, there is an internal satisfaction in sharing knowledge and fostering growth in the next generation of professionals for industry. Without an intrinsic sense of accomplishment, there may be little incentive for a professional to donate their time. These internal rewards must be supported by faculty through recognition and presentation of "letters of appreciation" from the College.

Faculty benefit through maintenance and upgrade of personal skills in the face of changing technology, having a pathway to keep course material current, developing a broader personal network, and intrinsic rewards of providing a better student experience.

4. Adopting Industry Fellows for Online/Distance Courses

The delivery method should not detract from the benefits of combining participation and technical expertise from industrial experts with pedagogical expertise of faculty. The challenge of this research was to adapt the face-to-face interactions of the Industry Fellows model into the online/distance education delivery for technology and engineering education.

This paper presents a case study of two information and computer technology (ICT) courses, which were delivered 100% online. Each course was, in itself, a unique case study involving professionals from different industries and involved student projects that were specific to the curriculum requirements of the course. The cases introduce two hybrids of the Industry Fellows model. However, the integrity of Industry Fellows was maintained in that industry professionals acted in the "participant" version, actively involved with the course instructor in designing and developing student projects, interacting directly with students, and evaluating and providing feedback to students. Discussed in detail are the processes used to recruit industry professionals, methods used to jointly develop content, modes of communication and collaboration, and assessment methods to evaluate student outcomes. The results of post-course interviews with the industry professionals, surveys completed by students, and self-assessment by the instructor are also discussed.

4.1 Case Study 1: ICTN 4406 – IPv6 Fundamentals. (Online Undergraduate Course)

A single industry partner was brought in to develop a real world project that would have the students work as a team, research and solve problems, and present findings. The industry professional participated on a weekly basis through virtual meeting software for the entire eleven week summer semester.

- Projects: Industry fellow developed five case study projects for students to complete.
- Deliverables: Students presented to the executives and engineers of the company during weekly virtual online meetings using Saba Meeting [6]. Students received feedback from the company representatives and made necessary adjustments and corrections to their work.

- Learning Outcomes: Problems solving, working as a team, presenting, applying classroom concepts, providing real world data. One student team was able to publish and present their work at the Rocky Mountain IPv6 Task Force North American IPv6 Summit conference and received an Academic Achievement award from the IPv6 Task Force.

4.2 Case Study 2: ICTN 6880 – Advanced Topics in Information Infrastructure Design (Online Graduate Course)

Two industry partners from two different industry segments were brought in to develop two distinctly different projects. Involvement of each professional was on a weekly basis, but only for half of a fifteen-week semester.

- Project 1: The first project was a case study based on the actual design and building of a new manufacturing facility in Saul Paulo, Brazil. Students worked in teams to solve real-world based problems related to the building a network infrastructure in another country.
- Deliverables: Students developed a project plan and had to submit Gantt charts, work breakdown structures, bills of materials, and network topology diagrams. These deliverables were reviewed by both the faculty and the industry fellow prior to weekly online meetings with the class. During online class meetings the students presented their work and had to justify their decisions.
- Project 2: The second project was research into converged infrastructure technology. Students were expected to work independently to research topics provided and present after completion of the study.
- Deliverable: Formal presentation of findings during online class meetings.
- Learning Outcomes: The industry professionals provided valuable feedback and insight that can only come from first-hand experience. Students gained insight into the unique challenges involved in carrying out an information technology project in a foreign country. They were exposed to real-word situations and problems, which are not covered in textbooks. Feedback was also provided on the student's presentation and speaking skills as they presented to company executives.

5. Discussion of Survey Results

Prior to conducting this research, the authors contacted Dr. Tenenberg regarding his survey instrument and to request permission to use it. After discussion, it was decided that for this study, a similar but more in-depth instrument would be utilized. The major difference between the two surveys is that the Tenenberg work utilized face-to-face sections, while this study used online courses with the intent to compare methodologies for impact upon online delivery for distance education. The survey was designed and administered using Qualtrics, data summarized with SAS statistical software JMP Pro 11.2. In total, thirty-five surveys were sent to students in the case study classes, twenty-one returned, and seventeen determined to be useable for a forty-nine percent response rate.

The survey instrument, found in Appendix A, begins with a block of Likert Scale questions concerning the impact on the learning due to the participation of industry professionals. Survey results for individual questions are shown in Appendix B in histogram format and summarized in a Table 1 as a comparison to the original baseline Tenenberg Industry Fellows research. The baseline data is segregated by "light" and "heavy" based on the prior stated definitions. For the baseline-summarized data, the survey response rate was one hundred percent of eighteen students in the light class, and eighty nine percent of thirty-seven students in the "heavy" classes.

5.1 Survey Questions Comparison of On-Line to Face-to-Face Delivery

The values in Tables 1 – 3 show combined responses for agreeing or strongly agreeing with a positive impact on the survey prompt for the original Industry Fellow study and the research for this study. Comparisons are drawn against only the "heavy" model as that was closely aligned with the process used for this research. The "light" data is presented as information only, although additional research could be warranted due to more favorable responses.

The first two questions on motivation to do coursework and motivation to attend class in this block are identical to the original Tenenberg questions [1]. The results are shown in Table 1 and indicate that the "heavy" Industry Fellow model had a comparable impact on motivation to do the course work although there was less of an influence on attending class. The lower percentage to attend may be an influence of outside factors such as presence (or lack thereof) a formal attendance policy, or the nature of face-to-face classes compared to distance delivery.

Table 1. Industry Fellow Impacts: Motivation and Attendance

Survey Question	Original "Light"	Original "Heavy"	Replication Study
Motivation to do coursework	94%	79%	76%
Motivation to attend class	94%	88%	59%

Tenenberg's third question was split into two, separating course engagement activities into stand-alone queries for inside or outside activity engagement whereas the original study combined both into a single question. For comparison purposes, Table 2 shows the same result for the original study as compared to the replication. Given the relatively small sample size and considering that other factors for assignment point deductions/class participation are not considered, the results indicate a comparable benefit using the "heavy" Industry Fellows model.

Table 2. Industry Fellow Impact on Engagement

Survey Question	Original "Light"*	Original "Heavy"*	Replication Study
More in-class engagement	94%	79%	76%
More outside class engagement	94%	79%	71%

* Same value used as question was combined in the original

Tenenberg's fourth question on learning was divided four ways, separating learning into retention and comprehension, while segregating total course content and delivery by the industry professional. For comparison purposes, Table 3 shows the same result for the original as compared to the replication study. While showing positive results, distance education delivery did not measure up to the same level as the original "heavy" study. This could indicate an inherent difference in face-to-face versus online delivery, or a reflection of the sociocultural influences that are a tenant of the Industry Fellow model. Even when using video technology for virtual classes, it is difficult to replicate the personal interaction of a true face-to-face class.

Table 3. Industry Fellow (IF) Impact on Learning

Survey Question	Original "Light"*	Original "Heavy"*	Replication Study
IF material: comprehension	94%	91%	82%
IF material: retention	94%	91%	76%
All material: comprehension	94%	91%	82%
All material: retention	94%	91%	70%

* Original survey question: "Learning of the material in this course"

The second block of Likert Scale questions pose questions concerning how an Industry Fellow type course compared to traditional, instructor only delivery. Survey results for individual questions are shown in Appendix C in histogram format and summarized in a Table 4. These questions are unique to the replication study, i.e. they were not part of the original Tenenberg Industry Fellows research. In general, Table 4 indicates a positive influence of the Industry Fellow model for online application. When compared to a non-Industry Fellow course, forty two percent stated that the industry professional's presence was a motivator for attending class, which is always a challenge for online courses that do not require attendance. Additionally, over half reported that the Industry Fellow either directly, as posed by question 2, or indirectly, as posed by question 3, increased the comprehension and retention by students.

Table 4. Comparing Online Classes: Traditional v. Industry Fellow

Survey Question	Strong Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. More likely to attend class	6%	18%	35%	18%	24%
2. More likely to learn due to presentation by industry professional	- - -	6%	29%	29%	35%
3. Attending class, rather than the industry professional, was the reason for learning	- - -	6%	29%	29%	35%

5.2 Free Response Survey Questions Comparison

Students in the original study had the following comments when asked to compare an Industry Fellows course against a typical/traditional, i.e. non-Industry Fellows, class [2].

- Legitimization of the course: "[The industry fellow's] presence helped us to think of our project as serious work rather than a practice exercise that simply simulated the real work."
- Connecting classroom to world: "The industry fellow ... helped tie in some of the key concepts that we would need to learn and be conscious of for work outside of an academic setting."
- A higher standard of performance: "The feedback he was able to give us on our milestones was well-grounded, and the fact that he didn't hold his punches made us more determined to work hard." "I feel that since we were going to be presenting our project to an industry professional, we wanted to increase the quality of the project."
- Student's value of academic and practical knowledge: "Having a representative from the industry provides a much needed alternate perspective. We have been able to get both the research and experimentation view alongside the practical hands on perspective."

The open response questions used by the replication study are listed in Appendix D. These questions were related to the original study but were intended to provide more granular feedback. The replication study open question responses were nearly identical for two questions, differences in course design and differences in course execution. Therefore, Table 5 combines responses for design and execution questions.

The positive comments closely parallel those of the students involved in the original Tenenberg study and reflect the student benefits of the Industry Fellows model. Common themes were: 1) legitimizing the course work, 2) connecting the classroom to the outside world, and 3) providing a perspective on the real-world application of their studies. However, there were negative responses in the replication study, whereas only positive responses are reported in the baseline.

The negative reaction was targeted at the industry professional pre-selecting writing topics for the course, but many students also deemed this a positive. On the plus side, students felt that having the industry professional provide a pick list of topics to write on created less stress on them to find a topic and provide confidence that their research would have real-world relevance. On the negative side, at least one student objected to not being able to research their own interest, indicating a misalignment between student areas of interest and the industry professional's area of expertise. This could perhaps be resolved through faculty intervention/approval of a topic off the list, or the student realizing the goal of the Industry Fellow model is focus on real-world applications within their discipline.

Table 5. Open Response Student Feedback

Open Response Question	Positive Response	Negative Response
Describe differences in the course delivery.	• See real world applications • Real world experience • Understanding business requirements • Unique access to professionals • More enjoyable	• Didn't see the value • Topics not as closely aligned with stated course objectives
Describe differences in the design/execution of semester assignments.	• Hands on approach • Paper topics selection by industry professional ensured relevance	• Not enough specific instruction • Paper topics selection by industry professional • No differences

6. Lessons learned

Planning Time: The baseline research provided an outline of three preparation meetings between the faculty and industry professional, to be carried out several months in advance. These preparation meetings covered: 1) student learning outcomes (skills), 2) specific work assignments, and 3) the weekly topic sequence [1]. The replication study reinforces that application of the Industry Fellows model is not an ad hoc approach. Involvement with the industry professional must be months prior to first class meeting to allow time for development of assignments, projects, or case studies.

Corporate Content Approval and Permissions, if applicable: Sharing of skills is not a corporate secret unless there are proprietary tools, processes, applications, or other artifacts deemed as "company confidential." The industry professional needs to have the course design complete in the case there is a need to get approval for sharing with students.

Virtual Meeting Software Preparation and Testing: Testing of remote collaboration solutions must also begin weeks prior to the start of class. Some collaboration software will conflict or will be incompatible with the software, firewalls, and security policies of the industry corporate environments. A solution must be identified and thoroughly tested to ensure that the industry professional will be able to seamlessly participate in online class meetings.

Virtual Classroom Student Preparation: Assignment instructions must be clear and detailed so students know exactly what is expected. This takes close collaboration between the faculty member and the industry fellow. Presentation and summaries from industry partner should be available at least one week prior to meeting to allow students' time to research the topic, so as not to waste the industry professional's time.

Virtual Meeting Recordings: Online meetings should be recorded to allow students unable to attend live and still obtain the information presented.

Industry Professional Recognition: As stated, the Industry Fellows model is a voluntary commitment of a professional's time. To help provide this sense of accomplishment, it is recommended to present the industrial partner with a "Certificate of Appreciation" from the College's Dean. This will express gratitude from more than just the instructor, and provide recognition suitable for a personnel file and/or resume.

7. Faculty Workload

Analysis of the case studies determined that faculty should limit themselves to a single Industry Fellow course per semester. Faculty need to spend additional preparation time to fully support the industry professional, and ensure that the process is smooth, to avoid a negative experience. Trying to incorporate industry partners in multiple courses seems to be too much of a hardship on the faculty member. A recommendation is to develop a single course based on a series of different Industry Fellows and modify, rather than create, the course curriculum, objectives, and syllabi annually.

Preparation should start a full semester prior to the course, as it will require several face-to-face and online meetings to come up with objectives, content and deliverables. Additionally, faculty and professionals should establish a thirty minute pre and post class meeting throughout the semester. Faculty should also plan monthly, hour-long meetings to discuss strategies, evaluate student work, and planning.

8. Methodology: Developing an Industry Fellows Class

There is a four-step process to establishing an Industry Fellows class, with at least a one-semester lead-time required. First, courses are identified in which inclusion of an industry professional would be appropriate, beneficial, and add value. This requires a review of the course objectives and assignments to see where an industry based project or case study could be included. The faculty must be fully versed on the course objectives and have a sound understanding of all material. It is also important to take into consideration the structure of the course and existing assignments to insure an outside industry project can be accomplished within the semester. Second, several potential professionals from industry are identified that have expertise and experience in the area of course topic and objectives. A good place to start to find such candidates is in existing industry advisory boards. The industry professional being recruited needs to understand that this is a partnership relationship, not a faculty member attempting to bring in an outside expert to teach a class. Third, potential industry partners must be contacted early to assess their level of desire to participate, availability of the time commitment, and establish the expectations. This crucial step is needed to gain "buy-in" from the professional. The fourth and final step is for the faculty and professional to meet regularly to

develop the level of the professional's contribution, development of content, pedagogy, and logistics.

The challenge to the Industry Fellows model, whether delivered as distance education or face-to-face, is that there are a lot of demands on those in industry. It is difficult to find professionals that have both a desire and time to commit to this academic endeavor. The objective is to develop a volunteer pool large enough ~~so~~ that no single professional is asked to participate more than once per year, or perhaps ~~to~~ participate every other year. Three avenues were used in this program to attract industry professionals: 1) personal faculty networks, 2) advisory board member companies, and 3) college functions. Personal networking contacts, when practical, were found to work best due to existing close relationship and rapport. Solicitation and recruitment by advisory board members within their own companies was also found to be a great source of potential willing professionals. A third, creative approached to recruit volunteers used at East Carolina University is by public recognition at our Career Networking Day luncheon. With corporate recruiters and faculty seated for lunch, the College Dean delivers a short speech to companies in attendance thanking them for the support of our college and the students. Following, the participants received a "certificate of appreciation", see Appendix F, to further show support from the college. This provides an excellent opportunity to request companies to find volunteers to add to the pool of willing industry professionals.

9. Sustainability

A critical aspect of any industry involvement program, including the Industry Fellows Model, is providing a methodology to create and maintain a flow of professionals to volunteer within an academic setting. There is a degree of self-motivation required from the professional, but the University has an equal responsibility to provide a sense of inclusion, accomplishment, and contribution. To these ends, Figure 1 denotes three factors employed at East Carolina University as a methodology to support the Industry Fellows program and ensure long-term

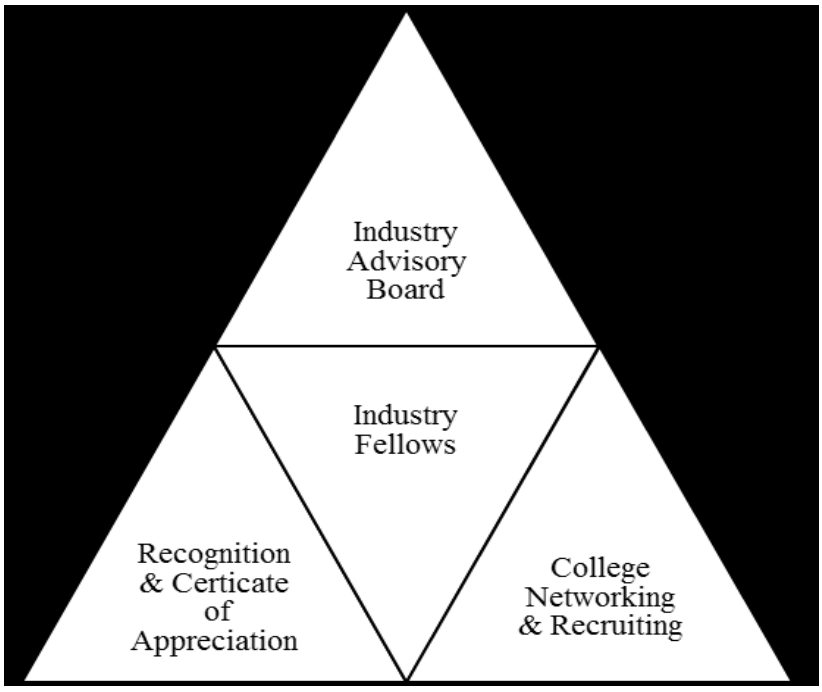

Figure 1. Sustainability of Industry Fellow's Model

sustainability of the methodology. As shown in the model, Industry Fellows links together other outreach and engagement efforts that include industry advisory boards, networking and recruiting events, and industry recognition.

Inclusion and recognition are accomplished through invitation and participation at two annual events, the departmental level Industry Advisory Board and the Annual College Networking Day. The professional is invited to attend both events as an honored guest for the day. At the Advisory Board meeting, there is a presentation of a "certificate of appreciation" signed by the College Dean. The professional is invited to stay for the day as an ad hoc board member to mingle with advisers, faculty, and students, to understand their contribution to the curriculum and assistance in securing a job upon graduation.

At the College Networking Day, a lunch is hosted for industry recruiters and faculty prior to the job fair portion with the students. At this lunch, the Dean's speech includes congratulatory words for the Industry Fellow program and the participants. These two events serve three purposes: 1) providing the professional with a sense of belonging (inclusion), 2) providing recognition and a sense of accomplishment, and 3) promotion of the Industry Fellow model to other professionals attending the events. Through these three activities, the Industry Fellows model maintains a key ingredient to the success of the program and provides an avenue to continually refresh professionals willing to participate.

10. Conclusions

Industry Fellows is part of a multidimensional approach to achieve the University's mission to develop business structures and practices needed to interact and innovate efficiently with partners in the public and private sectors. An industry fellow helps the university achieve its mission by increasing faculty and student engagement with industry.

There is no dispute that involving industry professionals is positive for faculty and students, as well as for the properly motivated industry professional. The data summarized in the above tables and student comments support that the model is a viable pedagogy for online instruction in distance education. The data support that the same benefits of engagement of industry professionals in face-to-face classes will transfer to online classes provided adequate compliance with the model and thorough preparation. The virtual technologies required for online classes seemed to be the primary roadblock to successful implementation in that business information technology infrastructure may clash with University applications. Otherwise, the goal of this research supports extending the Industry Fellows model from a face-to-face course delivery into online delivery for distance education.

As this model is time consuming and puts the College reputation in play via direct, voluntary industry involvement, teaching experience is required. The faculty must be able to integrate the Industry Fellow into the course objectives and outcomes, while being able to translate the experience and expertise of the professional into a curriculum. Faculty rank is not in question with this regard, just years of teaching experience and expertise with the course pedagogy.

Further research on the Industry Fellow model is needed to explore impacts of class meeting times, either face-to-face or online, to determine the availability and accessibility of industry professionals. There is an assumption that instructors generally default to night-time virtual meetings for online/distance education to accommodate a student population assumed to be working full time during the day. However, the validity of this assumption must be tested for engineering/technology-based curriculum. Additionally, utilization of evening virtual meetings may create a burden for an industry professional, thus inhibiting the application of the model. Daytime virtual meetings, scheduled into a business day like other meetings, may be an avenue of further research.

In addition, the "light" version of the baseline Industry Fellows research seemed to outperform both the "heavy" baseline application and the replication study for online application. This seems somewhat counter intuitive since there was a greater degree of personal presence and sociocultural engagement in the "heavy" and replication study. Additional research may investigate impacts of attendance policies, and further develop protocols for a "light" and "heavy" online Industry Fellows model.

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Appendix A. Survey Instrument

Default Question Block

Please indicate how much you agree or disagree with the following statements concerning how the participation of "industry professionals" in the course impacted your learning experience.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Increased my motivation to do the course work.	○	○	○	○	○
Increased my motivation to attend class.	○	○	○	○	○
Increased my engagement in the class activities.	○	○	○	○	○
Increased my engagement in the activities outside of class.	○	○	○	○	○
Increased my comprehension of the material delivered by the industry professional.	○	○	○	○	○
Increased my retention of the material delivered by the industry professional.	○	○	○	○	○
Increased my comprehension of the material covered in the course curriculum.	○	○	○	○	○
Increase my retention of the material covered in the course curriculum.	○	○	○	○	○

Please indicate how much you agree or disagree with the following statements concerning your learning experience in the course as compared to similar courses you have taken which did not included industry professional involvement.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I was more likely to attend class because of the industry professional participation.	○	○	○	○	○
I was more likely to learn in class because the industry professional presented material.	○	○	○	○	○
Attending class was what caused me to learn, regardless of participation by an industry professional.	○	○	○	○	○

Please describe differences in the course delivery of this course with industry professional involvement as compared to similar courses with no industry professional involvement.

Please describe differences in the design of your semester assignments and case studies in this course as compared to assignments and case studies in courses no industry professional involvement.

Please describe differences in the execution/completion of your semester assignments and case studies in this course as compared to assignments and case studies in courses no industry professional involvement.

Please briefly list any improvements that could be made to improve the participation of industry professionals in future courses.

Appendix B. How Industry Fellow Participation Impacts Learning Outcomes

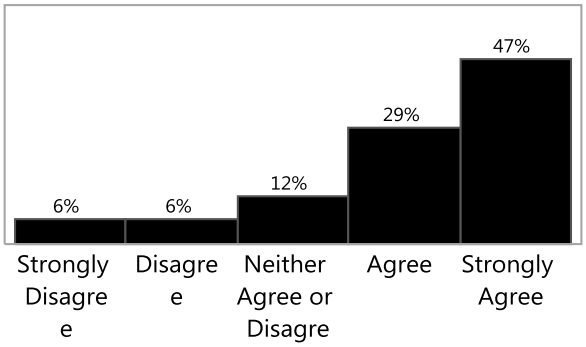

Figure 2. Increased Motivation to do Course Work

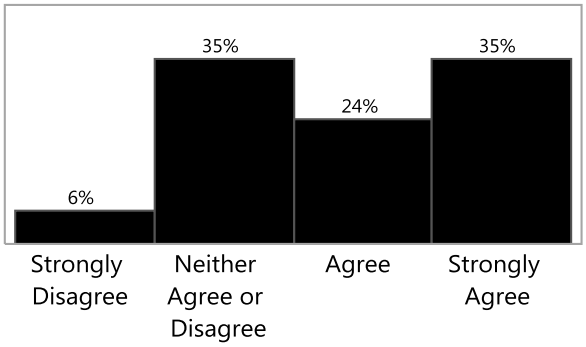

Figure 3. Increased Motivation to Attend Class

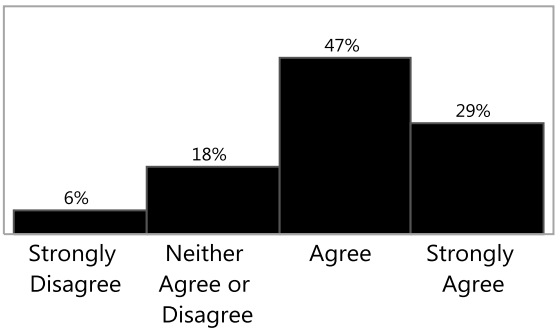

Figure 4. Increased In-Class Engagement

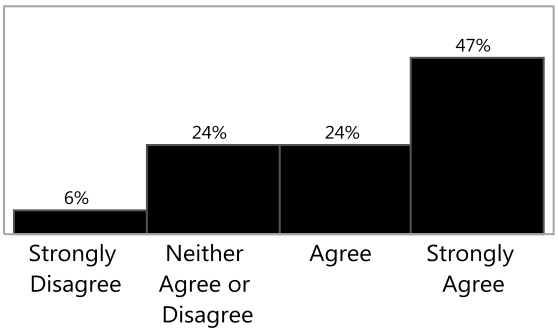

Figure 5. Increased Outside Activity Engagement

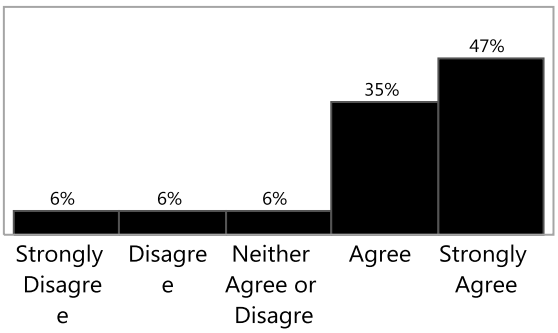

Figure 6. Industry Fellow Material Comprehension

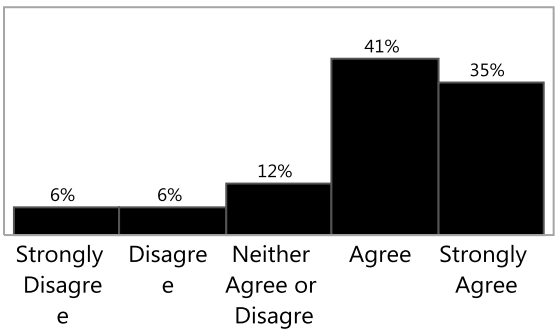

Figure 7. Industry Fellow Material Retention

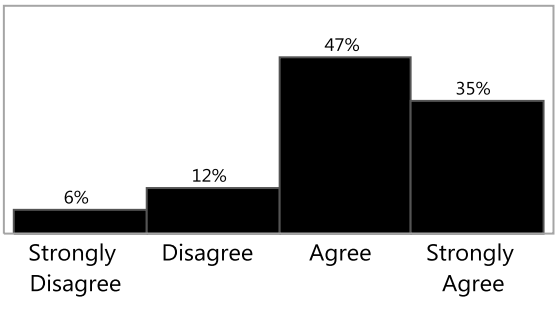

Figure 8. Increased Overall Course Comprehension

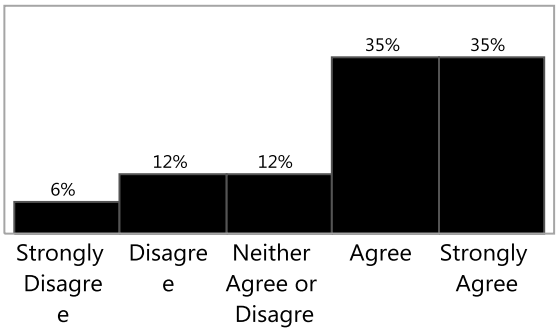

Figure 9. Increased Overall Course Retention

Appendix C. Industry Fellow Comparison to Conventional Delivery

Please indicate how much you agree or disagree with the following statements concerning your learning experience in the course as compared to similar courses you have taken which did not included industry professional involvement.

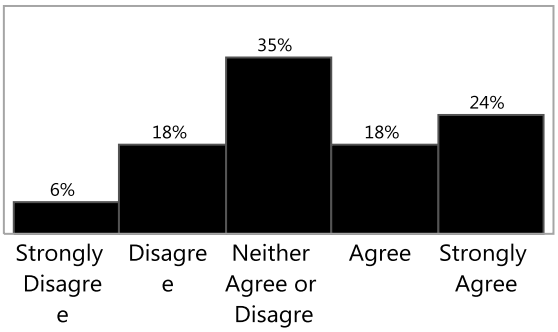

Figure 10. Higher Probability to Attendance

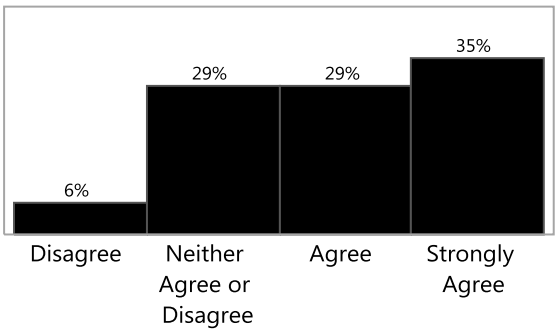

Figure 11. Industry Fellow Influence Learning

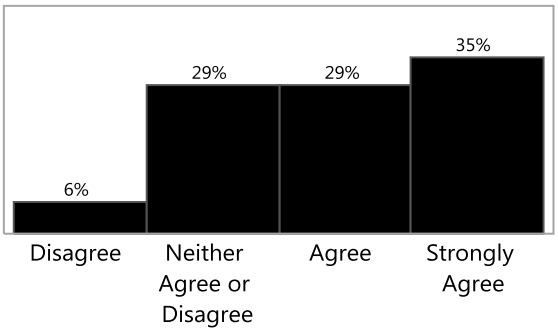

Figure 12. Attending Class Drove Learning, Regardless of Industry Fellow

Appendix D. Survey Open Questions Responses

Question 1: Please describe differences in the course delivery of this course with industry professional involvement as compared to similar courses with no industry professional involvement.
Positive

1. I liked that we were able to see what real world networks and experience was like.
2. The fact that workers from professional industries were involved with the course helped me understand business requirements and how the things we have learned are used in day to day operations. Other classes are more mundane and you don't really get to see real world examples other than course work.
3. This class gave us the opportunity to hear from people working in our field of study. We do not get this opportunity very often in other classes.
4. I liked attending the meetings and enjoyed the content (though I admit I rarely asked questions). However, having taken the Route course without the white papers/presentations and the Switch course with, I found it more difficult to produce quality white papers and prepare for the very heavily weighted certification exam. That isn't complaining - it's just a statement of fact. My favorite presentation was the OpenStack presentation - that was all new, relevant material that I did not receive in heavy Linux classes.

Negative

1. I enjoying hearing about other's work but I don't think it added that much to the course content.
2. The problem with the industry professionals was not so much having them there as it was having to write a white paper on their topics. I feel as a Route or Switch class from Cisco Network Academy, it would have been more beneficial to make us write reports on route and switch technologies.

Question 2: Please describe differences in the design of your semester assignments and case studies in this course as compared to assignments and case studies in courses no industry professional involvement.
Positive

1. The case studies in this class were more hands on and I think the fact that Netlab was being used was the main factor. I learned a lot from the book and got to apply that information on physical equipment. Many other classes don't have the type of equipment that was being used in the case studies.
2. This class allowed to pick topic presented by the industry professionals to write about. In other classes we usually have to pick the topics ourselves. Picking topics from the industry professionals' presentations allowed us to be exposed to some topic that we might not have heard of before or something that we had little knowledge of.

Negative

1. Normally the assignments also related to what we learned in the book. I don't think we were taught what we needed to do the assignments and were basically left to learn the material on our own.
2. The problem with the industry professionals was not so much having them there as it was having to write a white paper on their topics. I feel as a Route or Switch class from Cisco Network Academy, it would have been more beneficial to make us write reports on route and switch technologies.
3. There was no difference.

Question 3: Please describe differences in the execution/completion of your semester assignments and case studies in this course as compared to assignments and case studies in courses no industry professional involvement.

Positive

1. In this class we were given presentations to view and then given time to pick a topic and write about it. In this class we have the opportunity to go back and listen to the presentations as often as we needed to. In my other classes we are not given anything to view or listen to before picking a topic to write about.
2. Again, I think it was more difficult with the requirement of the papers and juggling meeting attendance. Saying that, I learned more for sure, and I enjoyed the increased interaction both with industry professionals and the instructor/classmates. If the papers were weighted a little more heavily (because they were very time consuming, or, at least attempting to write them with some level of quality) and the certification a little less, that might be a better balance.

Negative

1. I think the assignments were challenging but they didn't really involve the information taught in the class.
2. I don't think this correlated to my case studies being completed because of the professional involvement. It just made me understand the material a lot easier and focus in on what I needed to study more and what was being used by companies in the industry.
3. The problem with the industry professionals was not so much having them there as it was having to write a white paper on their topics. I feel as a Route or Switch class from Cisco Network Academy, it would have been more beneficial to make us write reports on route and switch technologies.
4. There was no difference.

Question 4: Please briefly list any improvements that could be made to improve the participation of industry professionals in future courses.

1. Instead to three case studies, it would be better if the case study was one big rolling project. Use parts of the case studies but case study 2 would actually be the last part of the project. So, information gathering, project requirements, project planning, material purchase and actual network design would be the last part of the project.
2. It felt like at times that the NetApp discussions were sales presentations.
3. I would rather have industry professionals every other week and actually attend lectures about course material the other weeks. It's good to hear what the professionals have to say, but I would have also liked to be taught course materials.
4. I think everything went well and there was nothing needs to be changed,
5. I think any improvements needed will come as guest speakers return, experienced with the format (and perhaps prepared to use Saba Meeting) - that's a practice thing. Actually, I wonder if you would consider inviting alumni from your classes to some of the meetings as attendees. It would be a great way for those folks to keep up with the technological 'happenings' from different industry sectors.

Appendix E. Industry Fellow Questionnaire

Please answer the following questions concerning your experience as an industry partner engaged in the co-instruction of academic courses you have taken from our University.

1. Background

- Please describe your current position in your organization.
  Engineering, infrastructure management, training

2. Motivation

- What factors led you to decide to participate as an industry partner?
  Excellent opportunity for both the University and Nephos6
- How did your experience in the course fit with your professional work?
  Excellent opportunity to evaluate current product and implementation as well as real world testing by both entry level and veteran users.

3. How did it go?

- Did anything about the experience stand out as particularly surprising?
  Unfortunately, the quality of the material delivered by the majority of the students in the class was less than satisfactory. This however does not reflect poorly on willingness or delivery of the course material by the instructor. The students appeared engaged and interested, and the course was excellent, the students were just apathetic with regard to the deliverables.
- Was there anything about the experience that you found particularly challenging?
  Making clear to the students, the expectations for deliverables
- How would you rate the student level of engagement? (more or less than expected)
  Less
- Would you say the time required was more than, less than, or about what you expected?
  About as expected.

4. Value

- How would you characterize the value (if any) of industry partner participation as part of academic courses?
  Excellent for both parties. Gets students involved in real world situations as well as giving feedback to the industry partner and providing introductions for future employment.
- How, if at all, did being an industry partner participant in this course benefit you?
  Complete testing of current products as well as much needed research driving interest in other areas driving sales and additional partnerships.

5. Looking ahead

- If given the opportunity, would you participate in a future Industry Fellows class?
  Absolutely
- What might you say or what advice would you give to someone considering participating in an Industry Fellows course?
  Don't take these opportunities for granted. Give 100% to each assignment. Companies are always looking for new talent.
- What improvements could be made in to improve future industry partner/academic collaboration in the classroom?
  More rigid structure and clearly defined expectations.

Appendix F. Industry Fellow Certificate of Appreciation

< to be uploaded after double blind review >